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Subject:

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**Advanced Visualization in Solar System Exploration and Research (ADVISER):
Optimizing Science Return from the Moon and Mars**

Progress Report, Year 1: October 30, 2007 to October 29, 2008

Principal Investigator: James W. Head, III

This project is designed to: 1) advance space science knowledge, exploration capabilities, and teaching and outreach, and 2) research advanced visualization tools for space science and education, through ADVISER (Advanced Visualization in Solar System Exploration and Research), a problem solving environment (PSE) for planetary geosciences that integrates and extends the state-of-the-art in hardware and software technologies.

Our approach is to put geoscientists on or near planetary surfaces and provide them with virtual, extended versions of traditional field tools to solve significant scientific problems, using four basic features: 1) Geoscientist on or near the surface, 2) Importation and visualization of multiple, integrated data sets, 3) field kit development, and 4) ancillary virtual field instrument development.

Over this year we have completed or begun the following:

- 1) Incorporation of the IVR facility for an Engineering course on mission design (continuing) and a Synthetic Biology course.
- 2) Integration with navigation system: how to plan for field work and establish traverse planning highlights with ArcGIS in order to optimize the planned input to the IVR facility.
- 3) Established ADVISER capabilities in our Geoscience lab and are measuring and comparing ADVISER tasks done in Cave (CVV) and at a conventional desktop.
- 4) Continue debriefing by user systems: Graduate students have discussed and described their experiences with students and faculty with all IVR facility personnel in attendance; more detailed reports are underway. Undergraduate students have provided general feedback and others are doing hands-on work to help explore optimal user interface ideas (e.g., hand-held PDA device controls and applying the latest 'video-game-like' rapid response controls). A number of demos to visitors, including members of the education and industrial communities, and participants at a meeting of the American Society of Photogrammetry and Remote Sensing, are also providing good feedback.
- 5) Our research in the following areas resulted in a number of publications as follows:
 - a. Analysis of ancient regional glaciation on Mars (Dickson, J. L., J. W. Head and D. R. Marchant, Late Amazonian glaciation at the dichotomy boundary on Mars: Evidence for glacial thickness maxima and multiple glacial phases, *Geology* 36:5, 411-414, 2008)
 - b. Analysis of tropical mountain glaciers (Kadish, S., J. W. Head, R. Parsons and D. R. Marchant, The Ascraeus Mons fan-shaped deposit: Volcano-ice interactions and the climatic implications of cold-based tropical mountain glaciation, *Icarus* 197:1, 84-109, 2008).
 - c. Analysis of valley networks on Mars (Fassett, C. I. and J. W. Head, The timing of martian valley network activity: constraints from buffered crater counting, *Icarus* 195:1, 61-89, 2008).
 - d. Analysis of lakes on ancient Mars (Fassett, C. I. and J. W. Head, A new catalog of valley network-fed, open basin lakes on Mars: Implications for the surface and subsurface hydrology of the Noachian, in press, *Icarus*, 2008).
 - e. Analysis of recent gully formation on Mars (Head J. W., D. R. Marchant and M. A. Kreslavsky, Formation of Gullies on Mars: Link to Recent Climate History and Insolation Microenvironments Implicate Surface Water Flow Origin, *Proceedings of the National Academy of Sciences*, in press, 2008).
 - f. Analysis of lobate debris aprons (Ostrach, L. R. and J. W. Head, Volumetric estimates of Amazonian lobate debris aprons (LDA) in the mid-latitudes of Mars: Support for the presence of significant water-ice, Abstract 1652, 39th Lunar and Planetary Science Conference, Houston TX, March 10-14, 2008; Ostrach, L. R. and J. W. Head, Ring-mold craters (RMC) in lobate debris aprons (LDA) in the Deuteronilus Mensae region of Mars: Evidence for shallow subsurface glacial ice in lobate debris aprons, Abstract 2422, 39th Lunar and Planetary Science Conference, Houston TX, March 10-14, 2008).

The preceding efforts follow up on earlier work:

- 1) Imported and visualized multiple data sets, including MOLA altimetry and HRSC digital terrain models, HiRISE and CTX ultra-high resolution images, CRISM high spatial and spectral resolution imaging spectrometer data, and wind vectors and values for different seasonal atmospheric and climate conditions.
- 2) Placed 50 geoscientists on the surface of Mars to address scientific problems.
- 3) Prototyped important aspects of the field kit (field location, strike and dip determination, instant altimetry and profiles, traverse recording and on note-taking, etc.) and provided the geoscientists with these tools in the IVR environment.
- 4) Prototyped ancillary field instruments (e.g., virtual photography, virtual GPS, and the PDA field notebook) and provided the geoscientists with these tools in the IVR environment.
- 5) Continued integrating ROAM3 rendering system into the IVR environment; built toolkit on top.
- 6) Provided support for non-immersive desktop and immersive display environments.
- 7) Integrated ArcMap to formalize the initial correlation of data sets for enhancing data preparation for importing to the immersive environment.
- 8) Developed tablet PC pen-based UI to traverse planning application of ADVISER.
- 9) A Geosciences class (Mars, Moon, and the Earth) of 72 undergraduate university students used the facility during their course to plan the choice and exploration of scientifically interesting places on Mars, with another scheduled for a visit this fall.
- 10) Purchased hardware to explore the four-stage spectrum (desktop⇒fishtank⇒wall⇒IVR) and completed initial testing.

Under development are:

- 1) Initial mechanisms for tele-robotic viewing within Brown.
- 2) Initial mechanisms for tele-robotic viewing outside of Brown at NASA and with other users.
- 3) Data management solutions for ‘out of core’ data sets.
- 4) Techniques so that large data sets have low impact on interactivity (high frame rate and low latency).
- 5) Continuing to develop advanced visualization and rendering techniques so that large geology data sets can be viewed in immersive VR (i.e., high frame rate, low latency, without inducing cybersickness).
- 6) Explore and evaluate the four-stage spectrum (desktop⇒fishtank⇒wall⇒IVR).
- 7) Extending to additional science themes and topics.